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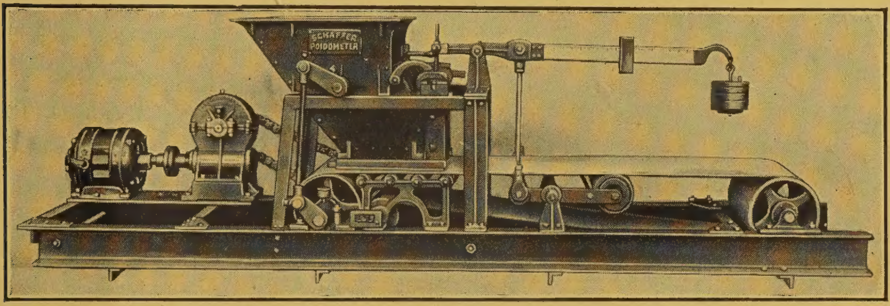

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MILL SECTION of

Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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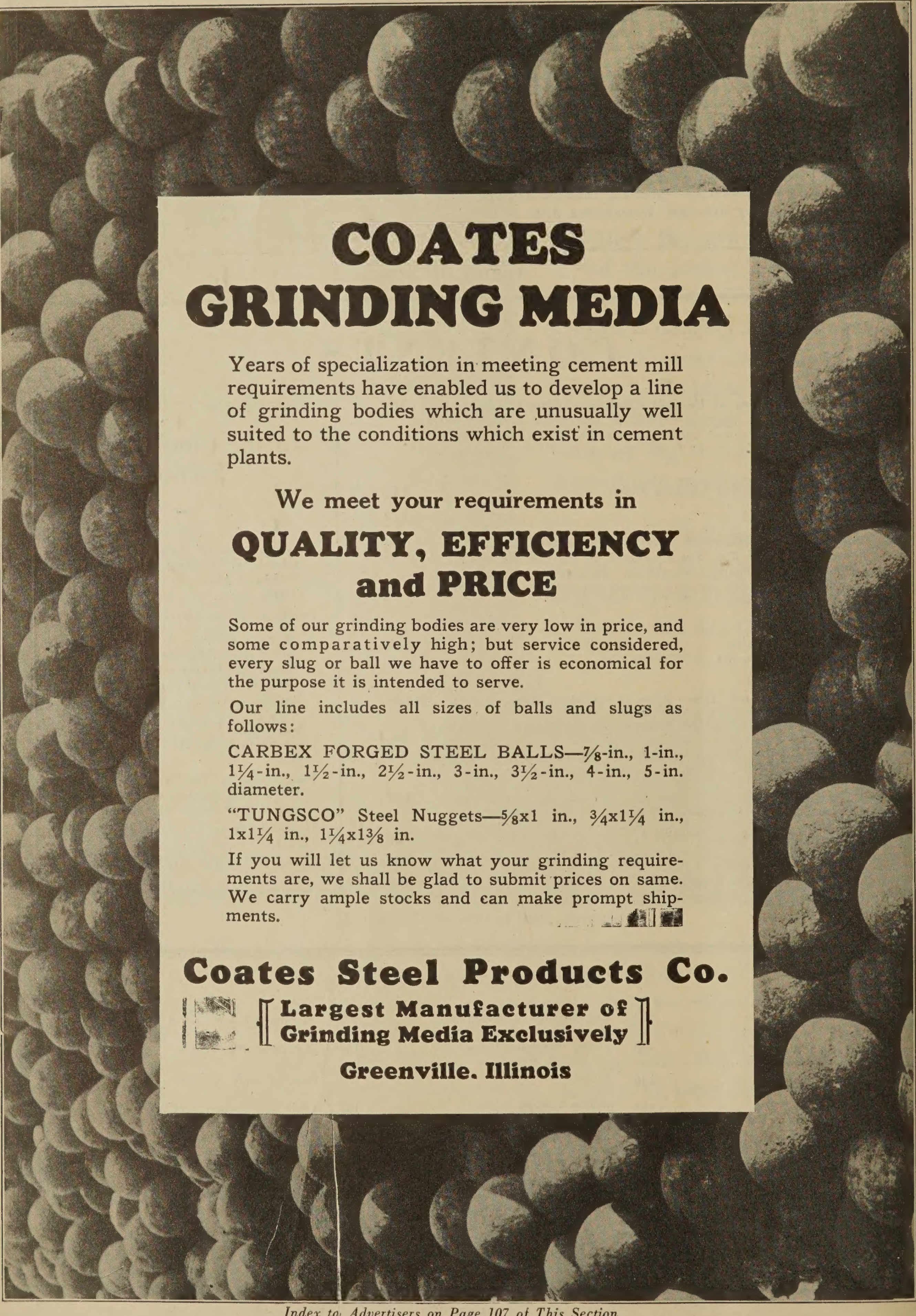

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MILL SECTION of

Concrete

Vol. 35 Chicago, August, 1929 No. 2

The Rate of Hydration of Cement Clinker

SYNOPSIS

The lack of knowledge concerning the rate of hydration of cement clinker has hindered a more complete understanding of the complicated setting and hardening reactions that cements undergo. Carefully sized fractions have been separated by prolonged elutriation with dried air and gauged with water under a variety of conditions. After varying periods of storage, samples were removed and rapidly dried. The partially hydrated material was ground in an agate mortar until a high degree of uniformity of size was secured. The ground powder was made into a slide and the ratio of hydrated to unhydrated determined.

Storage in water at 70 deg. F. resulting in the hydration of a layer of a typical portland cement clinker to an average depth of about one-half micron in 24 hours, 1.7 in 7 days, 3.5 in 28 and about five microns in 90 days, in the presence of calcium sulphate. In the absence of calcium sulphate, the penetration appears to be somewhat greater. Calcium chloride in the presence of calcium sulphate does not seem to have much effect on this reaction. A temperature of 32 deg. F. slowed down the initial reaction and one of 100 deg. F. increased it at early periods, but no appreciable difference could be detected at 28 and 90 days at either temperature from similar hydrating cement stored at 70 deg. F. One portland cement of high early strength was apparently hydrated more completely at 7 and 28 days than ordinary cement. The greater apparent hydration of a white portland cement is explained by the larger surface area due to greater irregularity in shape.

By F. O. ANDEREGG[1] and D. S. HUBBELL[2]

ONE of the most important fundamental properties of any hydraulic cement is the rate at which it will react with water. Knowledge of this rate is necessary for the understanding of the complicated setting and hardening processes that hydrated cements undergo. It is also of importance in connecting the fineness of grinding with the resultant strength and other properties.

Previous work on the direct determination of rate of hydration has been very meager. H. Hauenschild,[3] by observing the effect of hydration on the birefringence of portland cement particles, has reached the conclusion that those of a dimension of eight or fewer microns were completely hydrated within a short time. It should be pointed out, however, that the interference colors of most of the minerals in portland cement clinker are quite feeble and, with his method of observation would very soon be obscured by the products of hydration. Preliminary experiments with material of this size indicated that Hauenschild's conclusion was quite incorrect, only particles of less than two microns diameter being completely hydrated within 24 hours. The subject seemed of sufficient importance to justify a more careful determination of the rate of hydration of cement clinker.

Most of the experiments were carried out with a standard portland cement clinker, portland cement A, of average composition. In addition, another standard portland cement, cement B, one of high early strength, cement C, and a white portland cement clinker have been included.

Separation of Fractions

The separation of the cement into fractions of a suffi-

Paper presented at the thirty-second annual meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 24th to 28th.

[1] Senior Industrial Fellow, Atlas Portland Cement Co. Industrial Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[2] Industrial Fellow, Atlas Portland Cement Co. Industrial Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] H. Hauenschild, "The Particle Size of Portland Cement Flour and Its Effect on the Rate of Reaction," *Zement*, Vol. 15, pp. 453, 469, and 488 (1926).

ciently narrow range was accomplished in a Pearson elutriator[4] by prolonged blowing. At least one week of elutriation was required for each separation. The most important point in successful separation with this apparatus is to maintain the tube in very active vibration. This was secured by impacts from a small swinging hammer attached to the periphery of a disk revolving in the middle of a battery of three elutriators.

The stream of air issuing from a nozzle with an opening 2 mm. in diameter was directed downward against the cone-shaped bottom of the elutriator. The air was first scrubbed by passing through a cylinder packed with cotton waste. It was then dried by contact with 20 layers of calcium chloride supported on woven wire in a large steel drum. The velocities used were in the range where the relation between the pressure of the air and the dimension of the particle is linear and covered by the equation:

$$d = \frac{p}{3} + 10$$

in which d is the separation dimension in microns and p is the pressure differential in millimeters of mercury. The separation dimension was taken, with the exception of a few strays, as the largest dimension among the particles blown over, and as the smallest dimension among the residual particles. This was observed by measuring the images of the particles projected on to a screen with a magnification of 4400 times.

After separation of cement clinker of the dimensions shown by preliminary experiments to be most suitable, ranging from about 15 to about 35 microns, into 8 fractions of 20 to 30 g., each fraction was subjected to further blowing, starting with the largest particles. Any cement blown over was added to the fraction of next smaller size. Two fractions of larger diameters were obtained in a similar apparatus but having a smaller diameter (1.75 in.). Figures 1 and 2 show the typical size of particles in two of the fractions.

Gauging and Storage

About 2 to 3 g. of cement were mixed next with about 30 per cent of water to normal consistency with one minute of working with a spatula. It was then packed into a small (¼ by 1 in.) test tube and stored in a thermos bottle for the first 24 hours and thereafter in a minimum amount of water, so as not to lose much by leaching. It was observed that lime crystals tended to grow on the outside of some of the specimens, especially where no calcium sulphate had been added, but in amount too small to affect the final results. Most of the experiments were made at standard conditions, although the results of mixing and storage temperatures of 35 deg. F. ± 5 deg. was observed that lime crystals tended to grow on the F. and 100 deg. F. ± 5 deg. F. were also determined. The amount of mixing water, the time of mixing and the method of storage, were also varied. In addition, calcium chloride was added in three experiments.

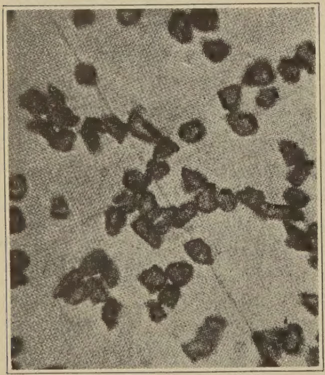

Figure 1

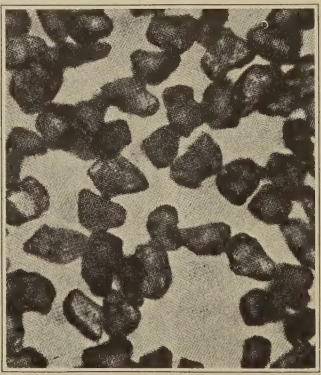

Figure 2

Since the calcium sulphate had all been blown out of these fractions, an amount was introduced in part of the experiments, in proportion to the surface area as compared with that of a regular cement. For this purpose plaster of paris was added, so that the SO_3 content should be increased 0.80 per cent for most of the fractions, and by a smaller amount of two fractions of larger dimensions.

Samples about the size of a pea were broken from the stored specimens at definite intervals and were dried at 110 deg. C. to stop hydration. That the hydration of the gauged fractions is completely stopped by this method was concluded as a result of the observation that a sample gave a count one month after drying that checked within 0.5 per cent, not only of the count determined immediately after drying, but also of the count made on the same material from which only the superficial water had been allowed to evaporate at room temperature. These observations also supported the conclusion that the index of the hydrated material had not been raised above 1.67 by this method of drying.

The first step in determining that portion of the clinker which had become hydrated was accomplished by grinding small bits from these dried fragments in a small, highly polished agate mortar as finely as possible, and to that point (determined by the microscope) where the fragments were very nearly the same size and very few if any remained that were appreciably larger than the others. That this was actually accomplished was determined by the actual measurement of the area of all the particles contained in one quadrant in about 20 fields, selecting every twenty-fifth field at random in each of three slides, all typical of those used for the counting.[5]

For the purpose of counting, three or more slides were made of some of this dried, partially hydrated material in an oil whose index of refraction was 1.67, a value lying between those of the unhydrated cement minerals and those of the products of hydration.[6]

The total number of particles and the number lying above (or below, whichever were fewer) the index of the oil were counted accurately, a total of about one thousand particles being observed in each case. In the comparatively few instances where particles were found of area somewhat greater than that of the range in which most of the material lay, an effort was made in the counting to assign the proper weight. For instance, a particle of double the area of the typical particle would be counted as 3 particles.

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[4] J. C. Pearson and W. C. Sligh, U. S. Bureau of Standards, *Technologic Paper No. 47* (1915).

[5] The images were projected on to a ground glass plate at a magnification of 510 diameters, and areas corresponding to certain definite size ranges were determined by comparing with standard areas. There were 4998 particles in the first range between 2.5 and 5 square microns, 306 between 5 and 7.5, 10 between 7.5 and 10, none in the fourth range and two in the region lying between 13 and 16.7 square microns. The amount of material of area below 2.5 square microns was found, with the aid of the ultramicroscope, to be a negligible part of the whole. With the dark field illumination it was observed that the particles were actually composed of aggregates of very fine material clumped together during the preparation of the slides into agglomerations of quite uniform size. The individuals in any group were largely either unhydrated clinker or hydrated cement, but the separation was not complete. A check on the method of counting was then made by taking three known mixtures of unhydrated clinker and nearly completely hydrated cement (checked by a separate count). One of the mixtures contained mostly hydrated cement, one mostly unhydrated clinker and in the other the two were present in about equal portions. The calculated checked the observed in each case within 2.5 to 3 per cent, which appears to be about the accuracy of the method. This means that the error in the depth of hydration is probably ± 0.2 micron.

[6] A. A. Klein and A. J. Phillips, "The Hydration of Portland Cement," *Journal*, Washington Academy of Science, Vol. 4, p. 573 (1914); also U. S. Bureau of Standards *Technologic Paper No. 43* (1914).

The procedure of comparing the indices with that of the oil was, briefly, that known as the Becke method, or rather a modification of it. The slide was placed on the stage of the microscope (using the 4-mm. objective and the 10 occular) and the substage diaphragm was stopped down almost completely. The fragments were brought into focus and then the tube was raised slightly to the fine adjustment. Such elevation caused each particle either to brighten or darken according as its index was above or below that of the oil. The work of counting was greatly facilitated by employing a Euscope by means of which the image is projected on a screen where it could be viewed with both eyes. The screen was divided into ½-in. squares for ease of handling.

After a little practice very uniform results were secured in counting, which very frequently checked by two operators working independently, or by the same observer after a period of time. Typical examples of the results for the amount of unhydrated material, selected at random, were 34.1, 32.9 and 33.5 per cent for three slides made from the same material. Lack of space prevents recording these data in detail.

Estimation of Percentage of Original Clinker Hydrated

Examination of the cement after separation, but before it was mixed with water, indicated the presence of a few grains of calcite and other minerals having indices below 1.67. The percentages of these grains was determined by actually counting several hundred particles of each fraction. This correction was of the order of 2 per cent and has been included in the results given in Table I. The

Table I.—Results of Tests on Hydration of Cement Clinker

Mean Dimension, microns	SO_3 Added, per cent	Gauging Method	Storage Method	Percentage of Clinker Hydrated				
				24 hours	41 hours	7 days	28 days	90 days
			PORTLAND CEMENT A					
15.53	None	Standard	Standard	......	33.7	70.0	89.1	92.4
16.53	None	Standard	Standard	......	13.1	66.4	81.6	88.3
	0.80	Standard	Standard	17.1	......	57.2	72.7	84.1
	None	Standard	Standard	......	7.5	65.0	......	......
18.67	None	Standard	......	......	21.5	63.4	79.8	85.6
	None	Standard	......	......	24.0	61.3	74.2	86.8
	None	Retempered after 30 minutes	Dry after 7 days, Standard	......	10.8	50.4	81.5	87.6
	0.80	Standard	Standard	......	......	43.5	69.0	90.0
20.69	None	Standard	Standard	9.5	......	69.6	78.9	90.3
	None	1.4 N. C.	Standard	......	19.0	68.2	84.7	89.2
	0.80	Standard	Standard	9.7	......	43.7	68.5	85.9
22.05	None	Standard	Standard	......	23.0	60.0	83.3	88.7
	0.80	Mixed 10 minutes with spatula	Standard	13.0	......	43.6	73.9	87.1
	None	Standard	Standard	7.3	......	28.5	67.3	85.9
	None	100° F.	100° F.	33.1	......	......	80.1	87.6
	None	32° F.	32° F.	7.6	......	......	80.7	88.3
23.57	None	Standard	Standard	......	18.3	61.2	76.7	86.9
	None	Standard	Standard	......	14.2	55.4	80.5	88.2
	0.80	2 per cent $CaCl_2$ solution	Standard	14.5	......	21.7	57.8	78.3
	0.80	Standard	Standard	10.3	......	33.0	68.6	86.6
25.53	None	Standard	Standard	......	16.8	52.3	79.5	84.1
	0.80	Standard	Standard	16.3	......	42.7	77.6	83.0
25.60	0.88	100° F.	100° F.	14.8	......	47.2	......	......
	0.72	32° F.	32° F.	5.3	......	18.7	......	......
38.60	0.27	32° F.	Standard	2.0	......	19.5	......	......
	0.27	$CaCl_2$=2 per cent of cement	Standard	6.0	......	25.2	......	......
	......	......	3 hours	......	4 days	......	......	......
63.33	0.10	Standard	Standard 3.3	6.0	85.1	12.5	......	......
	0.10	$CaCl_2$=2 per cent of cement	4.5	7.0	8.5	12.0	......	......
			PORTLAND CEMENT B					
26.73	0.80	Standard	Standard	8.1	......	......	33.6	......
			PORTLAND CEMENT C					
27.13	0.80	Standard	Standard	10.0	......	......	47.2	78.1
			WHITE PORTLAND CEMENT					
27.98	0.80	Standard	Standard	15.7	......	......	55.1	78.5

absence of more than mere traces of hydrated cement in the material at the start of the experiment was indicated by these observations, evidencing the effectiveness of the drying of the elutriation air supply.

Any variations observed due to the presence of calcium chloride are within the experimental error, therefore the preliminary conclusion might be drawn that calcium chloride does not affect the rate of hydration. This should receive more study.

Hydration over short periods of time has apparently been slowed up by the low temperatures, and hastened by higher temperatures; but after storage of 7 and 28 days, the amount of hydration is apparently very nearly the same over the temperature range, 32 to 100 deg. F.

The results obtained with cement A were confirmed by cement B. The high early strength portland cement C. did not appear to have a greater rate of hydration at 24 hours than the others, although at 7 and 28 days an appreciably greater rate was observed. The 24-hour result has been repeated.

Table II.—Depth of Hydration

All Values Are Expressed in Terms of Microns

Mean Dimension, microns	—Hours—		——Days——		
	24	41	7	28	90
CALCIUM SULPHATE ADDED					
Portland Cement A:					
16.53	0.51	......	2.03	2.41	3.84
18.67	......	......	1.62	3.01	5.00
20.69	0.36	......	1.81	3.31	4.97
22.05	0.50	......	1.92	3.98	5.46
23.57	0.42	......	1.47	3.52	5.75
25.53	0.73	......	2.16	5.01	5.69
38.60	0.13	......	1.35	......	......
63.33	0.65	......	1.38	......	......
Average	0.47		1.71	3.54	5.12
Portland Cement B:					
26.73	0.37	......	1.70	......	......
Portland Cement C:					
27.13	0.47	......	2.60	5.37	......
White Portland Cement:					
27.98	0.77	......	3.27	5.51	......
NO CALCIUM SULPHATE ADDED, CEMENT A					
15.53		1.00	2.56	4.06	4.48
16.53		0.39	2.52	3.57	4.23
16.53		0.28	2.44	......	......
18.67		0.72	2.57	3.86	4.44
20.69		......	3.41	4.17	5.59
22.05		0.92	2.85	4.95	5.70
22.05		......	1.95	3.58	5.94
23.57		0.80	3.19	4.54	5.80
23.57		0.58	2.78	4.95	6.00
25.53		0.76	2.79	5.24	5.85
27.45		1.41	4.33	5.81	7.42
Average		0.76	2.86	4.39	5.55
SPECIAL CONDITIONS					
$CaCl_2$, 2 per cent of cement and sulphate		0.39	1.78 1.32	....	....
$CaCl_2$, 0.7 per cent of cement and sulphate		......	0.90	2.94	4.70
1.4 Normal Consistency		0.71	2.64	4.82	5.42
Retempered after 30 minutes		0.40	1.95	4.01	4.68
Stored dry after 7 days		0.82	2.53	3.39	4.58
Mixed 10 minutes		0.50	1.92	3.98	5.46
Mixed and stored at 32° F.		0.28 0.37	...... 0.85	4.66 4.3	5.63 ......
Mixed and stored at 100° F.		1.38 0.66	...... 2.45	4.59 4.7	5.53 ......

The white portland cement appeared to react more rapidly than the gray cements. One reason for this was the much greater irregularity of the white clinker particles actually observed under the microscope.

A preliminary estimate gives the increase in volume of portland cement during hydration as about 50 per cent. As the hydration of the cement continues, the pores of a concrete should be diminished by the swelling cement. Given the size distribution of a cement, it should be possible to estimate the decrease in pore volume and in permeability with age caused by this swelling, but of course the calculation would not hold if material is transported and redeposited by moisture passing in and out.

The hypothesis of Giertz-Hedstrom and Werner[8] that the compressive strength of cement and concrete is proportional to the square of the part of the cement hydrated is confirmed in the case of cement A for ages of 1, 3, 7 and 28 days with specimens made according to A. S. T. M. specifications. Using the values given in Table II and knowing the size distribution, it is calculated that cement clinker A, a widely marketed brand, is 24 per cent hydrated in 24 hours, 42 per cent at 7 days, 51 per cent at 28 days, and 60 per cent at 90 days. Dividing the compressive strength in pounds per square inch by the square of the fraction of the cement hydrated gives a value constant well within the experimental error, 16,700 ± 500. It should be pointed out that this confirmation is probably accidental; for instance, on increasing the water-cement ratio, the hydration would not be decreased, while the early strengths are affected more than later ones.

The work is being continued with portland cements and also with the pure minerals found in cement clinker.

This method of counting leads to an estimate of the relative volumes of the hydrated and unhydrated cement. When the clinker is hydrated expansion takes place, requiring a correction for the change in specific gravity in order to determine what percentage of the original clinker has been hydrated. With dry kerosene in a small pycnometer, the specific gravity of the original clinker was found to be 3.192. A partially hydrated cement, in which the ratio of hydrated particles to total particles was 0.853, as determined by counting, had a specific gravity of 2.347 after the usual drying. The specific gravity of the completely hydrated cement after drying at 110 deg. C would then be 2.13. This correction has been applied to the results given in Table I.

Incidentally, these specific gravity determinations indicate a bulking of something like 50 per cent during the hydration of portland cement clinker.

Depth of Hydration

Assuming that the core of unhydrated cement remaining after a given period of hydration is similar in shape to the original particle, the depth of penetration of the hydration reaction is calculated by multiplying the cube of the mean dimension by the percentage of unhydrated material and extracting the cube root. This gives the mean dimensions of the core and the depth is one-half the difference between it and the original mean dimension.

The mean dimension was obtained by dispersing a small amount of a given fraction on a slide with absolute alcohol. The alcohol on evaporating left the particles adhering to the glass. The images of the particles were projected onto a screen at a magnification of 4400 times. The fairest long and short dimensions were measured for some 150 particles and the mean dimension was obtained therefrom by combining the average of larger dimensions with that of the smaller, the latter being taken twice. In the corner of Figure 3, two dimensions of 150 particles of the mean dimension of 18.6 microns are plotted.

---

[8] Stig Giertz-Hedstrom and Donovon Werner, "Strength Increase of Cement and Concrete," *Tek Tid.*, Vol. 58. Kemi 6, p. 41 (1928).

Attempts have been made to get a fair vertical dimension by focusing first on the surface of the slide and then on the top of each of several hundred grains. For this purpose a new and carefully calibrated micrometer screw was available. The average of several hundred such measurements has always been greater than the average of the smaller horizontal dimension. Now it seems logical to assume that the average of the vertical dimension should be the smaller, and the reason for the discrepancy lies in the fact that the highest point of each particle is brought into focus, while in the measurement of the mages, the fairest dimensions are taken. Therefore, intead of averaging the horizontal long and short dimensions with the vertical dimension it seemed fairest to use he smaller horizontal dimension twice together with the onger in calculating the mean dimension. It might be tated that the number of observations by the focusing nethod was sufficient to overcome the errors in measurng individual grains.

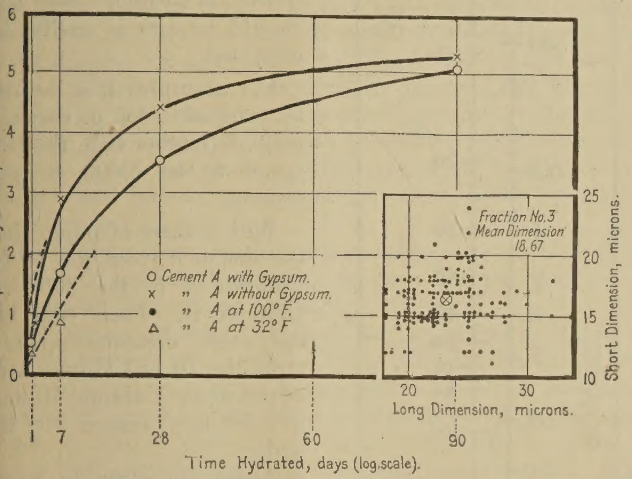

Figure 3

Other methods of obtaining the most probable dimenion, such as that of measuring a single horizontal dimenion;[7] or treating the observations by the method of least quares, or by plotting probability curves, were found by ctual trial to bring about only negligible improvements n the final result. To obtain some idea of the magnitude of this effect, calculations have been made for each one of 50 particles in the fraction of mean dimension 25.53 nicrons, where the scattering was greater than in most ractions. For depths of hydration of one and five mirons the correction was found to be about 5 per cent. The error due to the eccentricity and scattering of a properly sized fraction is not very great.

With a 10 per cent hydration the thickness of the hyrated layer for particles of mean dimension 22 microns vould be 0.39, and would reduce to 0.37 micron, if the imension had actually been 23 microns. At 90 per cent ydration the respective values would have been 6.34 and .85. A small error in the mean dimension will not have nuch effect on the final result.

Conclusions

The rate of hydration is rapid at first and then falls off, as is to be expected from the decreasing area of unhydrated clinker and from the ever thickening envelope of hydrated gel covering the surface.

The presence of calcium sulphate appears to slow up the rate of hydration between the first and twenty-eighth day of storage, as shown graphically in Figure 3.

At 24 hours the depth reached by the hydration of a typical portland cement clinker is about 0.5 micron, at seven days about 1.5, at 28 days above 3.5, and at 90 it appears to be about 5 microns, in the presence of calcium sulphate, and for particles of 15 to 30 microns dimension.

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[7] Henry Green, "The Effect of Non-Uniformity and Particle Shape on Average article Size," *Journal*, Franklin Inst., Vol. 204, p. 713 (1927).

Port Stockton Plant May Be Located at Pittsburgh, Calif.

Latest reports state that the proposed plant of the Port Stockton Cement Company, Stockton, California, may possibly be erected at Pittsburgh, California, instead of at Stockton. Lack of a suitable location is given as the cause of the change. Nine hundred fifty acres of raw material have already been purchased near Columbia, Calif.

Authorization has been given to issue to the public 130,000 shares of preferred stock and 65,000 shares of class "A" common in units of two and one at $50 per unit. Also to issue 195,000 shares of class "A" for conversion.

The company's capitalization includes 300,000 shares of preferred, 1,000,000 shares of class "A" common and 50,000 shares of class "B" common, all of no par value. The company already has issued in Nevada 50,000 shares of preferred, 300,084 shares of class "A" and 50,000 shares of class "B."

The company's preferred stock is entitled to dividends at an annual rate of $2 after January 1, 1930, and has a liquidating value of $25.

Riverside Portland Prosperity Shown in 1928 Report

The annual report of the Riverside Cement Company, just mailed to stockholders, shows the company with total net assets on December 31, 1928, of $11,472,276.50 which is equal to approximately $176.46 per share on its first preferred stock.

Current assets of $3,216,705.17 were more than six times current liabilities of $515,965.51. Profits for the period May 1 to December 31, 1928, before depreciation, depletion and federal income tax, were $1,353,642.50, and after those charges the net profit was $943,787.45.

This was more than five times the dividend requirements on first preferred stock. After dividends on first preferred and class A participating stocks, $255,500 was used to purchase first preferred for retirement, leaving a balance of $349,287.45 credited to surplus.

Merger of Large British Cement Firms Likely in Near Future

Reports from England indicate that the Ship Canal Portland Cement Manufacturers, Ltd., said to be the largest firm in the Red Triangle group, is about to merge with the other companies in the group. These are the Holborough Cement Co., Ltd., Dunstable Portland Cement Co., Ltd., and Greaves, Bull and Lakin, Ltd.

Proposed $34,000 Storage Building for Chelsea Plant

Tentative gubernatorial approval being secured, a $34,000 new storage building for clinker may be constructed at the Michigan state cement plant at Chelsea.

Superintendent M. H. McGaffigan has requested the addition to the plant for some time and appeared before the governor and the state budget director on June 25th to push his request. Governor Green approved the request pending further investigation.

The addition to the plant would follow out a recommendation of the governor to the last legislature. In a special message he declared that it would be necessary for the immediate construction of a storage building if the state continued to operate the plant.

The legislature generally assumed a hands-off policy in regard to the cement plant, pictured by some as a white elephant and by others as a boom to the highway building program. A bill to sell the plant was introduced but made little headway.

Any additional construction is subject to the approval of the state administrative board. The appropriation would be made from the general fund.

Calaveras Cement Stock Offered to Public

Public offering of its stock was made on June 18th by the Calaveras Cement Company, San Francisco, Calif. The shares include seventy-five hundred units of capital stock, each unit consisting of one share of 7 per cent cumulative preferred stock of $100 par value and one share of common stock at a price for both of $107.50 and accrued dividend to yield 6.51 per cent.

Application is to be made shortly for the listing of both stocks on the San Francisco stock exchange.

Earnings applicable to common stock on the basis of present capitalization were $1.31 a share, annual average, for 34 months of operation; $3.90 a share for 1928, and current earnings this year at an annual rate of over $5 a share. The company has already built up a surplus in excess of $540,000, and its cash position should be at least $1,000,000 by the end of 1929, it is estimated.

New Belgian Incorporation

A new firm, Cimenteries et Briqueteries Reunies, has been incorporated at Antwerp, Belgium, with a capital of 320,000,000 francs ($64,000,000).

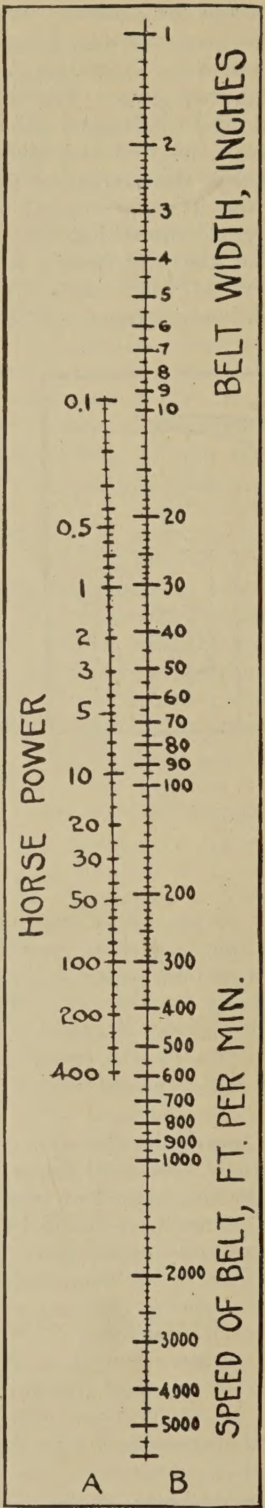
French Firms to Build Cement Mills in Morocco

The annual report of the French colonial firm, Chaux, Ciments et Materiaux de Construction au Maroc, shows a net profit of 3,926,536 francs ($785,307). The capital will be increased from 14,000,000 to 22,000,000 francs ($2,800,000 to $4,400,000), the 8,000,000 francs ($1,600,000) additional capital to be utilized in acquiring shares in the new Societe Marocaine de Ciments Lafarge, the Moroccan branch of Lafarge and Tiel, which firm will erect and exploit a modern cement plant in Morocco.

Another new African cement producing firm, Societe des Ciments Libanais, has been incorporated with a capital of 18,000,000 francs ($3,600,000). A mill with an annual capacity of 50,000 tons will be erected at Tripoli, Liban.

Belt Power Easily Determined by Chart

By W. F. SCHAPHORST



The accompanying chart is designed for figuring the belt width necessary to transmit any given power, the horsepower that is to be transmitted and the speed of the belt being known.

Or, if the belt width is known and if the speed is known, the horsepower can be determined. Or, if the belt width is known and the horsepower is known the speed at which the belt should be run is easily determined.

For example: It is desired to transmit 10 h.p. through a single leather belt, the belt speed to be 3,000 ft. per minute.

With a sheet of paper find the distance from the 10 in Column A to the 3000 in Column B. Then step off the same distance upward from the 10 in Column A to a point in Column B and there's the answer—3 in. wide.

Again, for example, if we have a belt 4 in. wide and wish to transmit 20 h.p. with it, what must be the speed of the belt?

With the same sheet of paper measure the distance from the 4, Column B, to the 20, Column "A." Then from the 20, Column A, measure downward the same distance to a point in Column B and there is the answer—4000 ft. per minute.

Again, let us suppose that you have a 9-in. single belt running at 2000 ft. per minute. What horsepower will it transmit?

Find the mid-point between the 9, Column B and the 2000 Column B. Directly opposite the mid-point in Column A is the answer—22.5 h.p.

A very easy way in which to find the exact mid-point is to lay a sheet of paper along Column B, the upper corner being exactly opposite the 9, Column B. Make a mark on the sheet of paper opposite the 2000, Column B. Then fold the paper bringing the upper edge down to the mark and make a crease in the paper. The crease will fall exactly at the mid-point. This is an accurate and very quick way in which to bisect any line.

The Cause of Unsoundness of Portland Cement

A Report of the Factors Causing Abnormal Expansion, Cracking or Distortion, Which Sometimes Occur When Portland Cements Are Subjected to Accelerated Tests for Unsoundness

By WM. LERCH
Portland Cement Association Fellowship, Bureau of Standards, Washington, D. C.

(Continued from the July issue)

Effect of added lime, magnesia and alkalies.—In some instances, portions of the clinkers which had produced unsound pats were ground to pass the 100 sieve and heated in the electric furnace described by Hansen and Bogue.[24]

Two of the sound clinkers were ground in the same manner with respective known quantities of calcium carbonate, basic magnesium carbonate, and a mixture of sodium and potassium carbonates. These were heated in the electric furnace.

The clinkers obtained in this manner were ground with gypsum in sufficient quantity to give 2.0 per cent SO_3, fineness of 90 per cent through a 200 sieve.

The results of soundness tests on the products obtained in this manner are given in Table VI. In this table are given also the maximum temperatures to which the samples were heated; free lime as determined by the ammonium acetate method; ultimate composition, and the compound composition. The ultimate composition in this case is calculated from the composition of the original clinker and the added material. The compound compositions with added alkalies are not included since the high percentages of alkali may materially change the quantity of some compound. In the cements containing added alkalies, the ammonium acetate titration would include free lime plus free alkalies. In these cases the lime in solution after completion of the titration was determined gravimetrically and found to be equal to the free lime calculated from the titration. This indicates that under these conditions the alkalies have gone into combination with the acid constituents and have displaced some of the combined lime.

Magnesia Content

The cements made from mixtures containing 5.0, 8.0, and 10.7 per cent of magnesia were found by both microscopic and X-ray examination[25] to contain a considerable quantity of uncombined magnesia. Samples from the steamed pats prepared from these same cements were subjected also to microscopic and X-ray examination. Free magnesia could not be found by the microscopic study of the steamed material but the lines for uncombined magnesia were found in each case in the X-ray diffraction patterns. Hydrous magnesium oxide was not observed by either procedure. This appears to indicate that a large part, at least, of the magnesia remains unhydrated in the steam test.

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[24] *Ind. Eng. Chem.*, 19 (1927), 1260.

[25] Microscopic and X-ray examinations by L. T. Brownmiller.

Table VI.—Results of Steam Tests for Soundness of Commercial Portland Cement Clinkers Subjected to Special Treatment in the Laboratory

	Ultimate Composition of Clinker							Compound Comp. of New Clinker							Time of Set (Gilmore)				Unsoundness	
Maximum Temperature of Furnace	CaO	Al_2O_3	Fe_2O_3	MgO	SiO_2	Ig. Loss	Material Added Before Forming New Clinker	Free MgO	$4CaO.Al_2O_3.Fe_2O_3$	$3CaO.Al_2O_3$	Free CaO	$3CaO.SiO_2$	$2CaO.SiO_2$	Per Cent Water Used	Initial H.	Initial M.	Final H.	Final M.	24 Hours	120 Hours
Orig.	63.2	4.9	0.5	1.3	25.0	2.4	0.0	1.3	1	13	5.5	19	57	23	3	10	7	45	Uns.	Uns.
1375		Would change only in proportion to change in ignition loss.					0.0	1.3	1	13	2.5	31	48	23	3	15	6	30	Uns.	Uns.
1400							0.0	1.3	1	13	1.9	33	45	24	4	30	6	45	Uns.	Uns.
1425							0.0	1.3	1	13	1.0	37	42	24	4	15	6	30	O.K.	O.K.
1450							0.0	1.3	1	13	0.3	39	41	24	4	15	6	30	O.K.	O.K.
Orig.	65.0	4.1	4.2	3.8	22.3	0.3	0.0	3.8	13	4	2.0	53	24	25	4	40	7	30	Uns.	Uns.
1375		Approximately the same					0.0	3.8	13	4	0.0	61	18	24	4	15	7	0	O.K.	O.K.
Orig.	64.9	7.4	2.8	2.1	21.8	0.4	0.0	2.1	9	15	0.4	41	32	23	2	50	4	30	O.K.	O.K.
1375	67.7	7.1	2.7	2.0	20.8		$CaCO_3$	2.0	8	14	0.0	61	14	24	4	30	7	0	O.K.	O.K.
1375	69.0	6.7	2.5	1.9	19.3		$CaCO_3$	1.9	7	13	5.9	60	10	25	3	10	5	45	Uns.	Uns.
1375	59.7	6.8	2.6	10.7	20.1		$MgCO_3$	10.7	8	14	0.0	41	27	25	5	15	7	30	O.K.	O.K.
1375*	63.0	7.2	2.7	2.0	21.2		Na_2CO_3 K_2CO_3				1.9			25	0	20	2	0	O.K.	O.K.
Orig.	66.0	4.9	4.6	0.8	21.9	1.4	0.0	0.8	14	5	0.6	60	17	23	4	0	6	30	O.K.	O.K.
1375	67.6	4.6	4.3	0.7	20.9		$CaCO_3$	0.7	13	5	0.6	71	6	25	4	30	7	0	O.K.	O.K.
1375	69.1	4.4	4.1	0.7	19.9		$CaCO_3$	0.7	13	5	4.7	75	2	25	4	0	6	45	Uns.	Uns.
1375	61.5	4.5	4.3	7.4	20.4		$MgCO_3$	7.4	13	5	0.0	59	14	25	5	45	8	0	O.K.	O.K.
1375*	64.0	4.7	4.4	0.7	21.2		Na_2CO_3 K_2CO_3							24	0	20	1	30	Uns.	Uns.

*Free alkali 0.0.

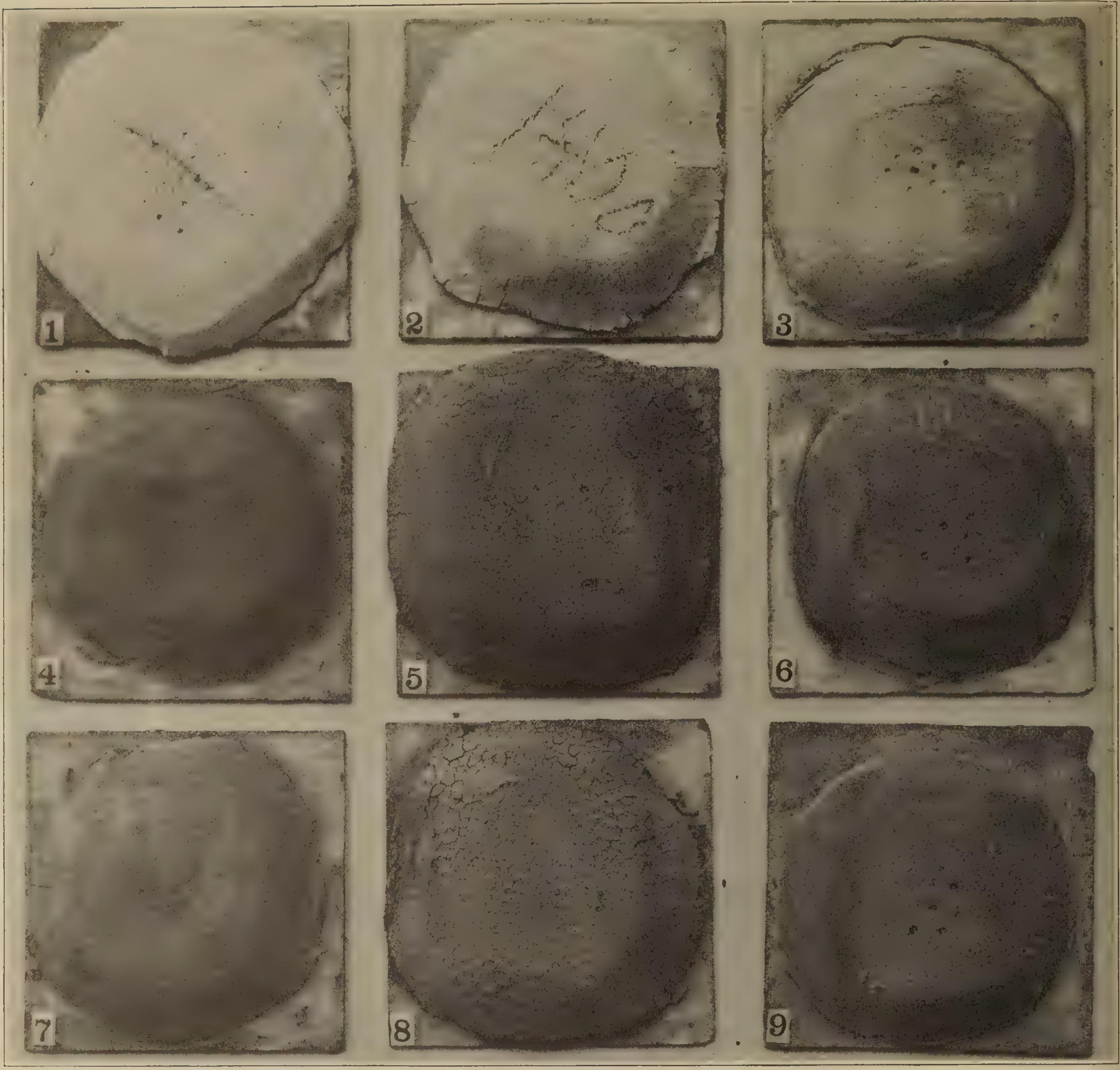

Figure 1

Fig. 1 illustrates the condition of a number of pats which have been subjected to the steam test. No. 1 is from an unsound clinker containing 5.5 per cent free CaO. The pat expanded beyond the edges of the glass, was very chalky, but due to lack of cohesive strength, shows only slight warping or cracking. No. 2 is from the same clinker but heated in the laboratory furnace to 1400 deg. C. It then contained 1.9 per cent free CaO. The pat warped at the edges and cracked. No. 3 is from the same original clinker but heated to 1450 deg. C. This clinker contained 0.3 per cent free lime and the pat is sound. No. 4 and No. 7 are from originally sound clinkers to which $CaCO_3$ was added in such quantity that the lime is practically all combined on heating at 1375 deg. C. No. 5 and No. 8 are from the same original clinkers (Nos. 4 and 7) to which $CaCO_3$ was added in such quantity as to leave considerable uncombined lime after heating at 1375 deg. C. These pats were greatly expanded and cracked. No. 6 and 9 are from the same original clinkers (Nos. 4 and 7) to which basic magnesium carbonate was added in amounts molecularly equivalent to the $CaCO_3$ added to Nos. 5 and 8 and the mixtures heated to 1375 deg C. These pats were in excellent condition.

Table VII gives the maximum and minimum concentration of component oxides and of pure compounds contained in the sound cements and in the unsound cements. The data given here are taken from Tables IV, V, and VI.

All of the commercial cements used in this investigation were tested by the standard method when the pats were 24 hours old. Duplicate pats, prepared from the same mix, were tested after curing in the moist closet for 5 days. Cements which were unsound at 1 day were also unsound at 5 days.

Another type of disintegration has been observed[26] with certain laboratory clinkers and mixtures of compounds in the absence of gypsum. In this case the disintegration occurred in compositions which were comparatively high in ferric oxide and which in the absence of gypsum show a very slow final set. This must be attributed to abnormal

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[26] Observed in certain laboratory clinkers by W. C. Taylor and reproduced in mixtures of $3CaO \cdot SiO_2$ and $\beta 2CaO \cdot SiO_2$ with either $2CaO \cdot Fe_2O_3$ or $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$.

Table VII.—Maximum and Minimum Concentration of Component Oxides and of Pure Compounds Contained in the Sound Cements and in the Unsound Cements

	Ultimate Composition						Compound Composition						
	CaO	MgO	Alkalies	Al_2O_3	Fe_2O_3	SiO_2	Free MgO	$4CaO.Al_2O_3.Fe_2O_3$	$2CaO.Fe_2O_3$	$3CaO.Al_2O_3$	Free CaO	$3CaO.SiO_2$	$2CaO.SiO_2$
Sound Cements													
Maximum	69.2	10.7	3.0	10.0	10.0	25.0	10.7	15	17	27	1.9	71	55
Minimum	59.5	0.0	0.0	0.0	0.0	20.1	0.0	0	0	0	0.0	18	6
Unsound Cements													
Maximum	69.1	3.8	3.0	6.7	4.3	25.0	3.8	13	0	13	7.8	75	57
Minimum	64.0	0.7	0.0	4.4	0.5	20.0	0.7	0	0	5	1.9	19	2

setting conditions. The pats eventually attained what appeared to be a final set in that they supported the heavy Gilmore needle. In reality this was due to partial drying and carbonation at the surface while the interior of the pats did not have a final set. When these pats were subjected to the steam test the surface layer was broken but the pats did not warp or leave the plate. These cements were not unsound in the usual sense of the term and could always be corrected by adding gypsum to the clinker before grinding.

Discussion

Unsoundness due to free lime.—The physical properties of portland cement are undoubtedly determined primarily by the properties of the compounds contained in the cement. This general principle would be expected to hold for the reaction of the cement in the steam test as well as for any other physical property. Hence the expansion of cements in the steam test has been investigated through the examination of the behavior of the component compounds in that same test.

It has been found that the pure compounds $3CaO.SiO_2$, $\beta 2CaO.SiO_2$, $5CaO.3Al_2O_3$, $3CaO.Al_2O_3$, $4CaO.Al_2O_3.Fe_2O_3$, and $2CaO.Fe_2O_3$, and mechanical mixtures of these compounds, will withstand the standard steam test without evidence of expansion, warping, or cracking. It was also found that a large number of laboratory cements and commercial cements, which contain those pure compounds in widely varying quantities, pass the steam test satisfactorily when prepared in such a manner that they contain very little or no free lime.

The magnesia and alkali contents of some of the laboratory cements were considerably greater than those of portland cements as manufactured at the present time. Yet the presence of the magnesia and alkalies did not cause unsoundness. Commercial clinkers to which magnesia or alkalies were added, and the mixtures subsequently heated to a sintering temperature, produced sound clinkers except in one case where the alkalies displaced so much lime, 7.2 per cent, that the free lime caused unsoundness.

Some of the commercial clinkers containing considerable free lime were found to be unsound. Two of these clinkers were heated in a laboratory furnace at a temperature that caused this free lime to combine. The clinkers thus obtained were sound.

Two commercial clinkers which were originally sound were found to remain sound when mixed with such a quantity of $CaCO_3$ that on subsequent heating clinkers were produced containing very little or no free lime. These same commercial clinkers when mixed with a greater quantity of $CaCO_3$ and heated to the same temperature produced clinkers containing a relatively high percentage of free lime (5.9 and 4.7 per cent) and were unsound.

Some laboratory cements and mixtures of compounds which in the absence of gypsum were very slow setting produced unsatisfactory pats, but this was found to be due to an abnormal setting condition in the absence of gypsum and was not unsoundness in the true sense of the term. This condition could always be corrected by the addition of gypsum.

It appears from these results that free lime was present in every case of unsoundness.

Other views on unsoundness.—A number of investigators, notably Kühl[15] and Erdahl,[9] have attempted to disprove the free lime theory by testing the soundness of mechanical mixtures of lime and cement. It must be borne in mind that in such mechanical mixtures the lime remains exposed on all of its surfaces to the action of water and so hydrates rapidly. The free lime in portland cement, however, as pointed out by Rankin,[10] is in part enclosed within the cement grains and is thus temporarily protected from the action of the water. This would partially prevent the hydration of the lime during the first 24 hours, but when the pat is subjected to the higher temperature of the steam test, the chemical reactions of hydration are accelerated and the water penetrates the protecting shell. This permits the lime to hydrate and expand the pat.

Kühl also objects to the free lime theory of expansion for the reason that during the setting of cement a large amount of calcium hydroxide is set free through hydrolysis of the calcium silicates without producing expansion. Hydrolysis on the other hand involves a solution of the silicate with a later precipitation of the reaction products. The crystallization of the lime liberated by hydrolysis will occur in voids. This is apparent from the laws of solubility. If the crystallization from solution sets up an increased pressure at any point, the solubility of the $Ca(OH)_2$ in this region of increased pressure becomes greater. This results in diffusion of the $Ca(OH)_2$ to regions of lower concentration. Thus the $Ca(OH)_2$ crystals formed through hydrolysis of the silicates would not be expected to produce abnormal expansion. In the hydration of free lime a new phase, crystalline $Ca(OH)_2$ may occur at the point originally occupied by CaO and since this new phase occupies a greater space an expansive force occurs.

Kühl believes that expansion in the accelerated tests is due to increased crystal formation. But since most cements pass a satisfactory steam test it would appear that the cements which fail in the steam test must then contain a greater amount of those compounds which hydrate with crystal formation. It has been found, however, that the pure compounds of themselves, and cements containing abnormally high concentrations of any pure compound other than free lime, will pass the steam test without evidence of expansion. It would appear, therefore, that the theory of crystal formation does not explain the abnormal expansion which sometimes occurs.

The amount of free lime necessary to produce expansion will depend on the ratio of expansive and cohesive forces as pointed out by Bates,[11] and on the fineness of the cement. Thus in cements having a high cohesive force a greater expansive force is required to cause cracking. In finely ground cements a greater amount of the free lime is exposed to the action of the water than in coarsely ground cements and so becomes hydrated before the cement sets.

The method of grinding employed in the laboratory is different from that of plant practice. The former is accompanied by very little or no heating, while in larger mills the heat developed in grinding is sufficient to cause a partial dehydration of the gypsum. The moisture liberated in this manner would be expected to produce a partial hydration of the free lime.

None of the freshly ground cements used in these experiments have exhibited the phenomenon of producing pats which are sound at 1 day and unsound at later periods. All cements which were sound at 1 day were sound at 5 days and all cements which were unsound at 1 day remained unsound at 5 days. The cements which Dwyer[16] found to pass the 1 day test and to fail at later periods had all been cured for some time before testing. The majority of the cements discussed by Dwyer were cements which had failed at 1 day when first tested but on exposure to the atmosphere attained a condition in which the 1 day pats were satisfactory while older pats were unsound. The explanation of these results appears to lie in the curing of the cements. On exposure to the atmosphere, the free lime near the surface of the cement grains becomes hydrated. The free lime in the interior of the grains is not affected by curing. When pats are prepared from these cements, only the exterior of the grains, which now contains very little unhydrated lime, is hydrated in the one day test. In tests of older pats the hydration of the grains has continued and when the pats are steamed at later periods a sufficient amount of free lime is hydrated to produce unsoundness.

Summary and Conclusions

The cause of the abnormal expansion called unsoundness which sometimes occurs when portland cements are subjected to the steam test has been investigated through an examination of the behavior in the steam test of the compounds which may be present in the cement, in conjunction with a quantitative determination of free lime.

It has been found that:

1. The pure compounds $3CaO.SiO_2$, $\beta 2CaO.SiO_2$, $3CaO.Al_2O_3$, $5CaO.3Al_2O_3$, $4CaO.Al_2O_3.Fe_2O_3$, and $2CaO.Fe_2O_3$ will all pass the steam test satisfactorily. No one of these compounds gives any evidence of abnormal expansion.

2. Various mixtures of these pure compounds and a mixture of equal amounts of $3CaO.SiO_2$ and $\gamma 2CaO.SiO_2$, as well as laboratory cements and commercial cements containing various quantities of these compounds, pass the steam test provided the free lime content is low.

3. The abnormal expansion which occurs when certain cements are subjected to the steam test is apparently to be attributed solely to the presence of free lime.

4. Unsound portland cements containing more than 2 per cent of free lime can be made sound by heating the clinker to the temperature required to cause the lime to combine, provided the composition is such that the clinker does not contain free lime at equilibrium.

5. Commercial portland cement clinkers which are sound will become unsound when mixed with $CaCO_3$ and heated at a temperature of incipient fusion if the resulting clinker contains sufficient free lime.

6. The quantity of free lime required to cause unsoundness may vary with different cements. From these results it appears likely that any cement with less than 1 per cent of free lime will be sound while cements with 3 per cent or more free lime are likely to be unsound.

7. Magnesia may be present in quantities greatly in excess of the present Standard Specifications for portland cement and not cause unsoundness as measured by the 5 hour steam test.

8. Alkalies do not cause unsoundness when present in such quantities as usually occur in portland cement.

Outlines Extent of Industrial Eye Accident Prevention

Countless thousands of eyes are being saved from destruction in hazardous industrial occupations through the use of goggles, machine guards and other protective devices, declared Louis Resnick, of New York City, representing the National Society for the Prevention of Blindness, in an address before the annual meeting of the Washington State Federation of Labor at Bellingham, Washington, on July 9th. Mr. Resnick described an unusual survey undertaken jointly by the National Society for the Prevention of Blindness and the National Safety Council which is to be published in the fall.

"For a long time, statistical material had been available on the number of eyes lost in industry and the cost of such accidents," said Mr. Resnick, "but little was known, prior to this inquiry, concerning the number of eyes saved through efficient safety work. We wanted to ascertain the extent to which blindness from industrial causes is being averted.

"It is, of course, impossible to secure any exact record of the number of eyes saved by the prevention of accidental injuries in industry. For the purposes of this study, however, it was assumed that every time a goggle lens had been shattered, pierced or spattered by molten metal or corrosive chemical while in use, an eye was saved from serious injury or destruction.

"The survey embodies the experience over a period of two years of 583 of the largest industrial plants in the country, employing more than half a million workers in hazardous occupations. It reveals that during the years 1926 and 1927 at least 2,757 men and women were saved from serious injury or total blindness in both eyes and 4,654 were saved from serious injury or total blindness in one eye.

"These figures, of course, include only the mines, shops, factories and mills to which questionnaires were sent for purposes of gathering data, and they represent merely a fraction of the large population of industrial workers in the United States. The survey demonstrates conclusively, however, that countless thousands of eyes are being saved from serious injury or destruction and millions of dollars in compensation costs and loss of wages are being saved employers and workers every year through the use of goggles, and mechanical safety devices in industry.

"The industries of the country are now paying approximately $10,000,000 a year as compensation to workmen who have been totally or partially blinded while at work. This is a direct loss. The indirect loss from this same cause is conservatively estimated as four times that figure. This annual expense of $50,000,000 is inevitably reflected in the cost of commodities and services and thereby in the cost of living."

~ EDITORIAL ~

Specification Revision

THE cement industry deserves commendation for its part in the action taken by Committee C-1 in proposing the inclusion of high early strength requirements in the proposed new specification for portland cements.

It was necessary to a constructive solution of the cement specification problem that the manufacturer indicate his opinion as to the practicability of a proposed change in requirements. When this was done, the way was opened to the committee and the new proposed specification is the result.

That the requirements proposed are practical from a manufacturing point of view is indicated by the fact that much of the cement marketed during the past year would have met the proposed specification.

◆

Capacity vs. Shipments

DURING 1928 the productive capacity of the cement industry was estimated at about 50,000,000 bbls. greater than the total sales for the same period. This year the gap between shipments and capacity will probably be slightly greater than for 1928. And in addition more new cement plants are under construction and in the process of promotion. The foreign cement situation has complicated matters in the coastal markets. In addition there was the problem introduced by the special cements.

The result is that the industry has had some tough sledding and that conflicting opinions of what should and should not be done have arisen.

The need for intelligent, progressive co-operative effort toward a solution of these problems was never greater than it is right now. Rather than curtailing co-operative effort, it would be wiser to intensify it if better conditions are sought.

But time has introduced some new aspects that did not enter into the plans when the industry first organized for co-operative promotion. These must be taken into account in planning future activities.

Chief among these is the matter of special cements. The number of cement manufacturers producing them has increased steadily during the past year. Naturally, these manufacturers find little of value to them under the present co-operative promotional activities. Their interests must be fostered individually and, to some extent at least, in competition with standard portland cement.

Is it impossible to organize all these activities, including those pertaining to the several types of special cements, under one head? Unless this is done there is danger of a division of interests—one group advocating one type of cement and another a second type, etc.

Perhaps it will be possible to find enough of common interest in these various cements to permit them to function in their promotional activities through a single co-operative organization. Such a course is preferable for obvious reasons if it is possible. But it will require tolerance and breadth of view. A step toward such united effort has already been taken in including the high early strength requirements in the proposed standard specification for portland cements.

Is it impossible to include some of the other cements of recognized quality that are now manufactured in conjunction with standard portland cement? Could not the scope of co-operative activity be widened to include such cements and others that may still be developed, provided they were of a quality high enough to meet a definite specification?

If this could be done, then the cement industry as a whole—special cement, high early strength cement and normal portland cement—could stand shoulder to shoulder to meet their common competitors. Then promotional activity can be intensified and the still very large undeveloped potential uses of concrete can be made to furnish a market for enough of the excess capacity to put the industry in a much more favorable position.

◆

Another Record

AGAIN the June accident prevention campaign hangs up a new record. Though six more mills reported in 1929 than did in 1928, the total number of accidents for June, 1929, was 40 against 42 in June, 1928.

The result is not as satisfactory as those conducting the campaign had hoped, but it sets a new figure to shoot at next June. A sudden spurt in production helped to increase the number of accidents.

The value of the annual June campaign is not confined to that month alone. Its effects are far-reaching and influence accident frequency throughout the year.

Each successive year that a June campaign has been conducted has shown a reduction in the number of accidents reported. It is not impossible to actually attain a perfect record and next year's campaign can be set down in the minds of cement plant employees as the time when the supreme effort will be made.

Favorable Effect of June Drive Seen in Accident Records

Forty Recordable Accidents Establish New Mark in Cement Plant Accidents—Six New Mills Included—Increase of Fatal Accidents to Four Mars Record

A NEW low record for cement plant accidents was made as a result of the accident prevention campaign held during the month of June, Portland Cement Association figures show.

There was a gross total of 40 recordable accidents for the month. The corresponding gross total last year was about 50, so that current returns would indicate considerable improvement in the reduction of accident frequency during the annual June campaign. The above figures represent the record of 159 mills which participated in the 1928 campaign as against 153 mills entered in the 1928 campaign.

More Plants, Fewer Accidents

Official figures for June, 1928, which include only the 136 mills from which the association received both man-hour and accident statistics, show 42 recordable accidents during last June. It is estimated that corresponding figures for June, 1929, will show about 35 recordable accidents. It is probably safe to predict that final June figures will show a reduction in accident frequency of between 10 and 20 per cent from those of last year. June, 1929, shows fewer accidents than any previous month since association accident records have been kept.

Revised frequency figures for the first half of 1929 as compared with the corresponding periods for the years 1925-1928 are as follows:

RECORDABLE ACCIDENTS

	1929*	1928	1927	1926	1925
January	59	63	133	197	249
February	51	76	108	183	232
March	46	91	140	198	252
April	73	101	152	171	236
May	75	82	110	174	234
June	40	42	59	204	92
Half year total	344	455	702	1127	1295

*1929 figures are gross totals. Other years are net totals, including only figures for mills reporting both man-hour and accident statistics.

Twenty-Three Plants Have Accidents

One hundred thirty-six mills or 85 per cent of those enrolled, completed June, 1929, without accident as compared with 124 mills which made a similar record one year ago. Twenty-three mills suffered one or more recordable accidents.

Four Fatal Accidents

The disappointing feature of the campaign was the four fatal accidents, as against one each in June, 1927, and June, 1928. Of this number one was suffered by a mill whose record does not appear in the annual tabulation and another has been tabulated as fatal although the victim is still alive but death is momentarily expected.

A comparison of the records for 1928 and 1929 gives the following interesting information:

	June, 1929	June, 1928
Mills enrolled	159	153
Gross recordable accidents	40	51
Gross lost time accidents	36	50
Gross fatal accidents	4	1
Mills suffering 8 accidents	0	1
Mills suffering 6 accidents	0	1
Mills suffering 5 accidents	1	1
Mills suffering 4 accidents	2	0
Mills suffering 3 accidents	1	1
Mills suffering 2 accidents	2	4
Mills suffering 1 accident	17	21
Mills suffering no accidents	124	136

June accidents classified by department are shown as follows:

Department	Number of Accidents June, 1929
Quarries	12
Mines	0
Clay Pits	0
Crushing	3
Raw	2
Coal Grinding	1
Burning	1
Finishing	1
Cement Storage	0
Packing and Shipping	4
Power	3
Shops	4
Yard	3
Other than above	1
Not given	5
	40

Study of Cement to Be Made by League of Nations

Washington reports state that the Economic Committee of the League of Nations, now giving thought to international tariffs, has announced that a large number of countries concerned in the production of cement would be willing to take part in a meeting to examine the customs conditions governing that product.

The holding of a consultation among experts from the United States and other countries under the sponsorship of the League is being considered.

Spanish Cement Plant

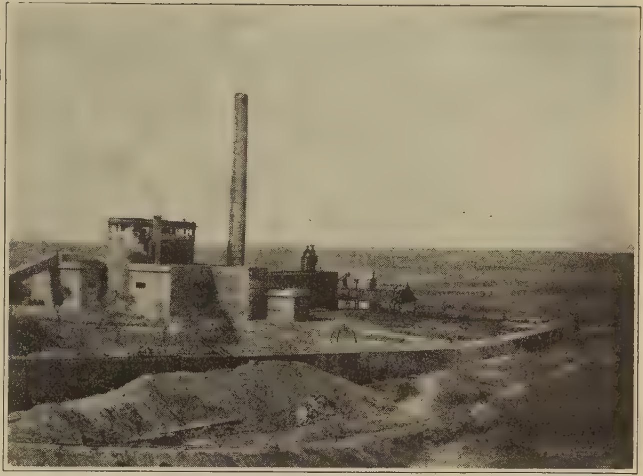
Located Adjacent to

Rich Raw Materials

A Description of the Newest Plant of the Compania General de Asfaltos y Portland "Asland," Villaluenga, Spain

Part I

IN 1901, his Excellency, Eusebio Guell y Bacigalupi, first Count of Guell, organized the Compania General de Asfaltos y Portland "Asland," marking the beginning of modern cement manufacturing methods in Spain. The first plant, using rotary kilns, was erected in Spain at Pobla de Lillet, Province of Barcelona, at that time. This first plant had a capacity of only 100 tons of portland cement daily, which at that time was sufficient to meet the needs of the Spanish market. As the demand increased, the company first enlarged its original plant and later, in 1917, erected another similar plant at Moncada, also in the Province of Barcelona. Though this plant increased the production of cement by 250 tons daily, it was soon inadequate to meet the increasing demands and in 1924 the company decided to build another plant in central Spain. This last plant was erected at Villaluenga and a description of it is the subject of this article.

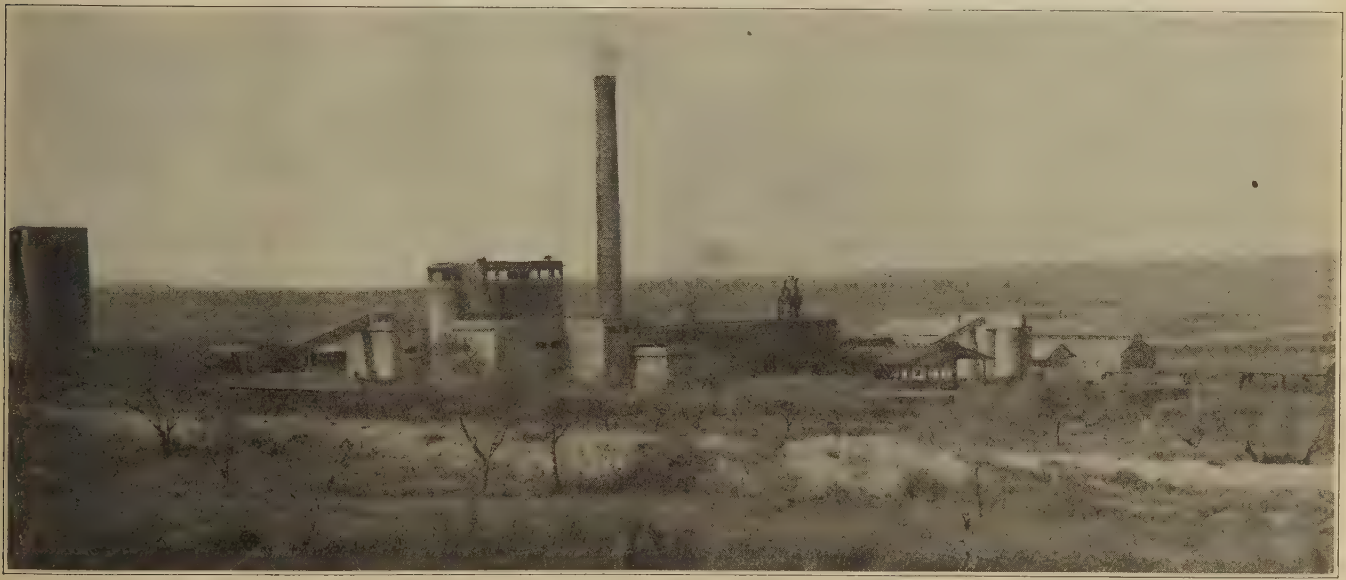


The Sagra district, where the Villaluenga cement plant is located, is rich in calcareous raw material

Location

Villaluenga is a village in the District of Sagra of Castile, renowned for its rich calcareous marls. It lies in the Province of Toledo near the Madrid-Malpartida Railroad and the Western Spain Railroad. It is favorably situated from a transportation standpoint, the Sagra District being traversed by two of the most important railroads in the country. The plant is located midway between these two railroads and the cement company built a branch railroad connecting the two main lines, thus providing excellent transportation connections with all of Spain and Portugal.

The Villaluenga plant is a dry process plant, designed and erected to incorporate progressive American and Spanish cement plant practice. The equipment was supplied by the Allis-Chalmers Manufacturing Co., and American and Spanish engineers co-operated in its design.



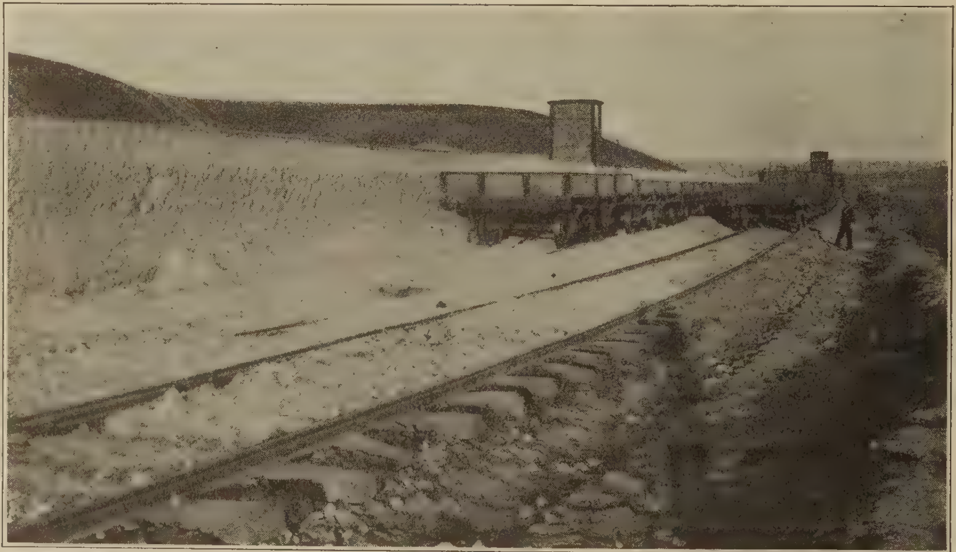
A general view of the Villaluenga plant of the Compania General de Asfaltos y Portland "Asland," in Spain

Raw Materials

The raw materials are calcareous marls, limestone and clay, obtained from Cerro de Villaluenga, the hill at the foot of which the plant is situated. The hill is formed of beds of marl carrying an average of 69 per cent $CaCO_3$, and having a composition so that with the addition of enough $CaCO_3$ to give the mixture the proper richness in that component, the raw material is secured. Thus the relation between the components SiO_2—Al_2O_3—Fe_2O_3, which make up the clayey part of the marl, is such as to permit the making of a good cement. The limestone runs 90 per cent $CaCO_3$ and comes from the limestone deposits of the township of Rielves y Huecas, village of the Province of Toledo, lying within 25 kilometers, or 15 miles, of the factory and connected therewith by rail. The analyses of the raw materials are as follows:

A portion of the limestone quarry at Rielves y Huecas township

	Marl	Limestone	Clay
SiO_2	19.94	7.64	49.32
Al_2O_3	6.95	2.04	22.20
Fe_2O_3	2.25	0.92	6.62
CaO	37.60	50.60	1.48
MgO	1.92	4.10	8.01
Insoluble	30.52	36.96	9.22



A train of cars loaded with rock leaving the quarry

Quarries

The Villaluenga quarries now being worked lie at an elevation of 68 meters (225 ft.) above the level of the crushing plant and are formed of marl strata of varying thickness separated from each other by thin beds of clay. The total height of the quarries is 30.42 meters (100 ft.), with a face of 700 meters (2296 ft.); the central portion, 140 meters (460 ft.) in width, tapering toward the ends. The quarry is operated by means of compressed air, the ordinary Ingersoll-Rand Jackhammers BBR-13 being used. The air is furnished by an Ingersoll-Rand compressor of the ER-1 horizontal type, driven by a 50-h.p. Allis-Chalmers electric motor. The rock is loaded into trains of dump cars and taken to the crusher. Besides this hill, the company owns others nearby, which have an aggregate area of 150 hectars (260 acres), and the formation of which is the same as that of the one now being worked.

Showing the method of loading rock on cars at the quarry

The limestone quarries of Huecas y Rielves consist of strata 3.50 meters (9½ ft.) thick with a face of 2000 meters (9240 ft.). Like the Villaluenga quarries, they are worked with compressed air and jackhammers of the type mentioned. The air is being temporarily supplied by a portable gasoline-driven 7- by 6-in. Ingersoll-Rand Type 20, which is being replaced with a 10- by 12-in. Ingersoll-

Rand horizontal belt-driven compressor, type EF-1, and a 50-h.p. Allis-Chalmers motor. Together with the installation of the compressor, electric transmission lines are being built to supply the power for it and for an electric caterpillar shovel, of the Bucyrus 50-B type, for loading the rock into cars.

Crushing Operation

The Villaluenga marl undergoes two crushings. First it is taken to a preliminary 36- by 48-in. Allis-Chalmers jaw crusher driven by a 100-h.p., 2200-volt a. c. motor installed in a building at the quarry. A belt-driven belt conveyor 24 in. wide, with a distance of 22 meters (216 ft.) between shaft-centers, carries the crushed rock to a 48-in. by 12-ft. revolving Allis-Chalmers screen, driven, together with the conveyor, by a 15-h.p. motor making 750 revolutions. The screen separates the material of less than 1-in. diameter and this falls through a hopper directly upon the conveyor, which takes it to the dryer bins. The coarser material falls directly into a cylindrical bin 10 meters (33 ft.) high and 5 meters (16 ft.) in diameter, at the top of which the screen revolves. This bin is built of reinforced concrete and holds 200 tons of rock.

The second crushing is performed by 42- by 16-in. Allis-Chalmers rolls, operated along with the conveyor which feeds them, by a 55-h.p. motor. The rock from the above described bin is carried to these rolls by means of a 20-in. belt conveyor, with a distance between shaft-centers of 11.25 meters (37 ft.), and after passing through the rolls the rock with a maximum size of 1 in., discharges upon the conveyor which carries it to the dryer bins. This conveyor consists of a 14-in. rubber belt, with a distance between shaft-centers of 185 meters (606 ft.), and capacity of 50 tons per hour. It receives its material directly from the rolls and operates for a distance of 100 meters (328 ft.) inside of a metal bridge covered with reinforced concrete, one end of the bridge resting on the ground, the other upon the dryer bins. It consists of three spans which rest on iron supports 18 meters (58 ft.) high and on the top of the dryer bins.

A scene at the quarry showing the arrival of the rock train at the crusher

The rock from the Rielves quarries is loaded directly into standard-gauge cars of 10 tons capacity, and is transported to the factory in trains carrying 300 tons, drawn by locomotives of the kind in use on the railroads in Spain. Upon reaching the factory it is unloaded into a reinforced concrete hopper holding 300 tons, at the bottom of which is a Gates gyratory crusher No. 5, capable of crushing 30 tons per hour and driven by a 35-h.p. motor. The ground material from this crusher discharges upon a 14-in. belt conveyor carried on iron supports, and having a length, between shaft centers, of 259 meters (850 ft.). It runs parallel to the main axis of the factory at the natural ground level, its walls being of concrete posts and cement brick, and its roof of concrete tiles laid on wooden sheathing. It discharges into a 30-ton iron hopper, opening below upon another conveyor running at right angles to the first and to the axis of the factory. This conveyor takes the material to the dryer bins; it has a 14-in. belt with a distance between shaft-centers of 94 meters (301 ft.) and a fall of 20 degrees; it runs inside of a covered way of reinforced concrete, supported by reinforced concrete pillars, and is driven by a 15-h.p. motor with a speed reduction of 30 to 750.

One of the long belt conveyors transporting raw material

Storage Bins and Dryers

The storage bins of the dryers are two cylinders 5.50 meters (18 ft.) in diameter and 18 meters (58½ ft.) high, holding 300 tons of rock each. They are of reinforced concrete with walls 6 in. thick and have hoppers at the bottom to carry the rock to the distributor which feeds the dryers.

The latter are two in number, 6 by 60 ft., with an inclination of ¾-in. to the foot and revolve at the respective speeds of one revolution and three-fourths revolution per minute. They are driven by a 15-h.p. motor running at 750 r.p.m. with a Font y Campabadal speed reducer of 120 to 750. All of the speed reducers used in the factory are of the Font y Campabadal make.

The dryers are heated with pulverized coal, conveyed to the coal bins of the dryers through 1¾-in. pipes, by means of compressed air.

Each dryer handles different material, one of them being for limestone and the other for marl, and discharges

The enclosed conveyors for limestone and marl, leading to the dryer bins

the dry rock upon 14-in. belt conveyors having an inclination of 20 degrees and a length between shaft-centers of 48.60 meters (166 ft.). These take the material to the bins for making up the charges, placed above the charging scales.

The bins mentioned are cylindrical in shape and of reinforced concrete; they are 4.40 meters (14 ft.) in diameter, 16.20 meters (52 ft.) high and their walls are 6 in. thick. There are four of them, two for limestone, one for marl, and the fourth for the clay which may have to be added to the mixture to correct any variation in the composition of the marl. The capacity of each is 600 tons. The mixture is made by proportioning the materials from the four bins by means of automatic scales (Schaffer poidometer), and sending the resulting product to the milling storage bins, over a 14-in. belt conveyor having an inclination of 20 degrees and a length between shaft-centers of 27 meters (86 ft.). The storage bins are of reinforced concrete. They are 4.40 meters (14 ft.) in diameter, 5 meters (16 ft.) high, with walls 6 in. thick, and hold 90 tons each. At the bottom of each is a conical iron hopper through which the material is fed to the compeb mill.

The marl crusher installation at the Villaluenga plant

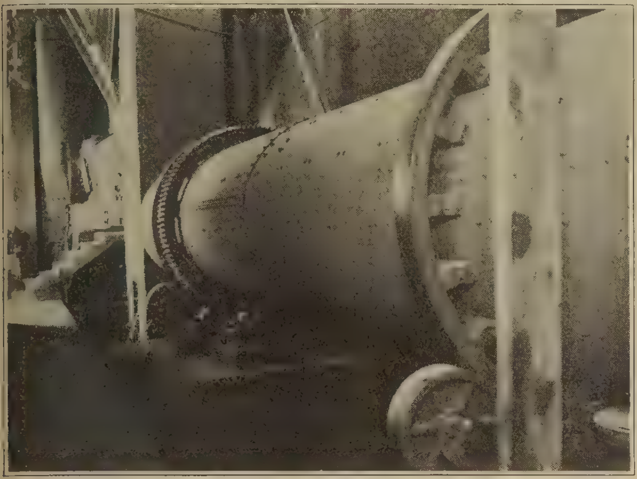
Grinding of the Raw Material

There is one single Allis-Chalmers compeb mill, 7 ft. in diameter by 26 ft. long, connected directly to a synchronous motor by magnetic clutch and charged with 5-in., 4-in. and 3-in. steel balls in the first compartment and with 73,000 lbs. of $1\frac{1}{4}$-in. Concavex in the finish compartment; the output of this mill is 20 tons per hour, with an average residue of 5 per cent on a 4900-mesh screen. The motor is a 500-h.p. Allis-Chalmers Type AK synchronous 90 to 95 per cent P. F., 3-phase, 50-cycle, 2200-volt, $187\frac{1}{2}$ r.p.m. and equipped with switchboard, automatic transformers and interrupters; the magnetic clutch is 60 in. in diameter.

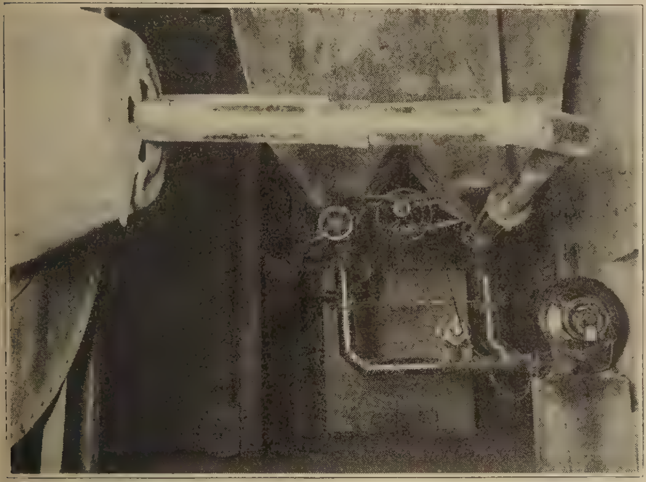
By combining the raw materials from the two quarries an unusually favorable composition is secured

For supplying power to the two compeb mills, there are installed in the main powerhouse a group of Allis-Chalmers direct-current $37\frac{1}{2}$-watt, 120-volt generators and a 3-phase, 50-cycle, 220-volt induction motor with switchboard. The 500-h.p. motor of the compeb is outside of the mill room and in the electric powerhouse, separated from the mill by a partition through which the shaft of the motor passes.

The product obtained from grinding the raw material is taken by a screw conveyor 16 in. in diameter and 13.75 meters (44 ft.) long, driven by a 12-h.p. motor with a speed reduction of from 750 to 30, and carried to a 16- by 8-in. bucket elevator with positive discharge, which raises the material and dumps it into another 16-in. screw conveyor 26.25 meters (84 ft.) long, running at right angles to the first along the top of the four rectifying bins, where it is distributed and classified for final mixing and for correcting any defects it may show.



Raw material dryers



The coal grinding mechanism for the raw material dryers

The rectifying bins, four in number, are of reinforced concrete. They are 5.50 meters (18 ft.) in diameter, 16.50 meters (53 ft.) high with 6-in. walls, and hold 500 tons each. The four are connected by a double deck and by the housings of the two elevators which run between them.

The fine-crushing rolls

Each bin is provided at the bottom with six rack-and-pinion gates which can be regulated at will, and which close the apertures from which the material escapes. The proper manipulation of these gates permits the making up of the exact charge wanted for the kiln; this charge

Showing the Schaffer poidometers proportioning the raw materials from the two quarries before they are pulverized

The combination mill for raw material

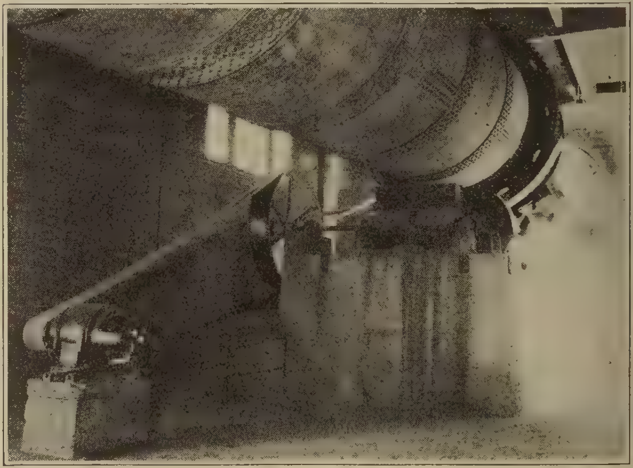
on passing through the gates, drops into a 16-in. screw conveyor, 26.25 meters (84 ft.) long, which takes it to a second bucket elevator similar to that described above. The elevator has a capacity in excess of what is required for feeding the kiln, for which reason part of the material which it raises goes to the kiln feed-bin, the rest being returned to the rectifying bins, where it is distributed and mixed with the material coming from the mill, thus reducing any error which the material may possess. In this way there is established a constant circulation of raw material, thus diminishing any error in the composition and insuring its complete uniformity. The two elevators are operated by a 15-h.p. motor each with a speed reduction of from 750 to 15, and the screws by a 12-h.p. motor each, the speed being cut from 750 to 30.

The kiln platform and the fans for the Raymond mills and the kiln

The rectifying bins, the distributing worm conveyor and elevator

Kiln

The kiln, made by Allis-Chalmers, is 10 ft. in diameter and 165 ft. long. It is of the rotary type, set with an inclination of ½-in. to the foot, and is rotated by a 60-h.p. motor of variable speed, ranging from 750 to 375 r.p.m. The kiln is lined with 3 in. of Sil-O-Cel, for its entire length, except the first 50 ft., where the calcination takes place. Its capacity per 24 hours is 250 tons of clinker running 66 per cent CaO. Heat is supplied by pulverized coal, the feeding of which is regulated by an Allis-Chalmers device consisting of a double 6-in. coal injector operated in conjunction with a Reeves Variable speeder and a No. 10, Type P, fan. The latter draws the air heated in the clinker-cooler, after the clinker-dust has been separated out in a dust-chamber, and supplies the kiln with the amount of heated air needed for the combustion of the coal. In this way a considerable saving of coal is effected.



The kiln transmission installation

(To Be Continued)

MEN and MILLS

Notes from the Field

Monolith Men Journey to Wyoming for Opening of Laramie Plant

One hundred officers, directors and shareholders of the Monolith Portland Cement and Midwest companies made a five-day tour of the new Midwest plant at Laramie, Wyoming, and the vicinity, leaving Los Angeles on June 20th.

The special train bearing the party arrived at Laramie Saturday morning, the 22nd. After the formal opening of the plant, the delegation was taken to a lodge in the Rocky Mountains, west of Laramie, for luncheon. Returning, short stops were made at Cheyenne, Denver, Colorado Springs and Salt Lake City.

C. A. Low, vice-president and general manager of the two companies was in charge of the party.

Okay, Arkansas, Plant Visited By Company Officials

A tour of inspection of the new plant of the Arkansas Portland Cement Company at Okay, near Nashville, Oklahoma, was made by company, railroad and state highway commission officials, on June 18th. A special train conveyed the party and the entire day was occupied by the trip.

The plant at that time had reached the stage where most of the equipment was ready to be operated and operation as a whole was to begin July 15th. Dwight H. Blackwood, chairman of the state highway commission, pulled the switch starting the rock crusher.

Service on the special train was one of the features of the trip, with Missouri Pacific officials as hosts.

The following officials of the Arkansas Portland Cement Company made the trip: C. Boettcher of Denver, Colo., president of that company and of the Ideal Portland Cement Company; C. D. Nichols of Oklahoma City, vice-president of the Arkansas company and of the Oklahoma Portland Cement Company; D. M. Pinkston, sales manager of Little Rock; M. O. Matthews, manager of operations, and Jack Canby, special representative of the company.

The project was first launched in August, 1928, when 800 acres 12 miles south and west of Nashville were purchased and construction was begun on Arkansas's first cement plant and one of the largest in the Southwest.

G. A. Ricker Assumes Charge of P. C. A. Bureau of Education

George A. Ricker, former well known Buffalo engineer, recently with the Portland Cement Association at Washington, has removed to Chicago to assume charge of its bureau of education there.

He was the guest of honor at a testimonial luncheon on June 6th, given by civil and social organizations and bodies working for District of Columbia suffrage at the Y. W. C. A.

Mr. Ricker began his engineering work on the Erie Railroad at 16 years of age. Two years later he entered Massachusetts Institute of Technology. After leaving there he was assistant engineer on the Erie road and later on the Northern Pacific Railroad in Montana. He surveyed and built the Niagara Gorge Railroad and was chief engineer of the Buffalo traction lines. He also built the first three concrete grain elevators in Buffalo harbor.

In 1913 he was appointed first deputy commissioner of highways of the State of New York. He started that state in the construction of concrete roads. In 1915 he was civil service examiner of the New York State Civil Service Commission and in the same year, he was consulting engineer of the New York State Automobile Association and editor of Motordom, its official magazine.

In 1916 he joined the Portland Cement Association of Chicago as highway engineer and in 1918 came to Washington as its representative. He is now going to the Chicago headquarters of the association to become manager of its educational bureau.

J. E. Jellick Joins Calaveras Cement Company

J. E. Jellick, for the last three years Pacific Coast manager for the Portland Cement Association, has joined the executive staff of the Calaveras Cement Company of San Francisco as manager of advertising and promotion. His appointment was announced by Arthur B. Shelby, general manager of the Calaveras company.

Jellick is a graduate of Idaho University and served with the Wyoming Highway Department and the Los Angeles county road department.

Cement Plant Man Boomed for Governor

John L. A. Galster, treasurer and general manager of the Petoskey Portland Cement company, Petoskey, Mich., would make excellent timber for the Republican nomination for governor, according to the Michigan press.

In political circles Mr. Galster has many friends and stands strong, especially in his home territory and Detroit, it is further stated. The favorable mention in reference to his possible candidacy started over a year ago, and has since grown to proportions that are considered quite promising.

Mr. Galster has made no announcement in reference to the matter, except to state that his first duty is to the ,cement plant, adding that politics and even fishing and hunting must all remain secondary to the welfare of the cement industry in Petoskey.

J. E. Zahn Named Member of Traffic Experts Group

J. E. Zahn, secretary of the United States Portland Cement Company, Denver, was named a member of the traffic managers and transportation experts committee of the Denver Chamber of Commerce.

Lone Star Cement Company Holds Barbecue at Greencastle

The Lone Star Brand cement mill, of the Indiana plant of the International Cement Company, at Greencastle, Ind., entertained between 10,000 and 12,000 persons on Wednesday, June 19th, with a barbecue dinner.

The guests were greeted by H. A. McBride, Indiana director, and R. J. Elledge, superintendent of the Greencastle plant. Guides were present to show visitors on tours of inspection to the rock quarries, and all electric current throughout the mill, except the power line operating the kiln, was shut off for the day, another step in the carefully laid safety plans. Special trains were in operation between the mill and the quarry.

Guests from 18 states and from the Hawaiian Islands, were represented in the throng of nearly 5,000 who registered.

The Greencastle Band played on the public square Wednesday morning and at the plant during the day.

Cement Statistics for June

June Production Lower—Shipments and Stocks Slightly Higher—Total of Plants Now 163

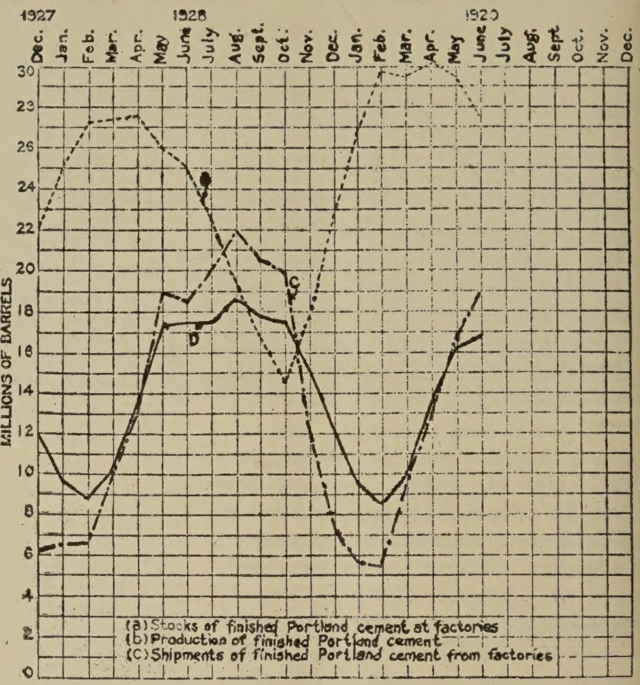
NOTE: IN ORDER THAT THE READER MAY KNOW THE TREND AT A GLANCE, THE HIGHER FIGURE, WHETHER FOR EITHER YEAR, UNDER ANY CLASSIFICATION, APPEARS IN SLIGHTLY HEAVIER TYPE.

Relation of Production to Capacity

(Figures represent per cent)

	June 1928	June 1929	May 1929	April 1929	March 1929
The month	**90.1**	80.9	76.4	67.1	47.4
The 12 months ended	**73.8**	69.0	70.2	71.1	70.9

	1928	1929	Increase or Decrease, Per Cent
Production, June	**17,497,000**	16,775,000	—4.1
Shipments, June	18,421,000	**18,939,000**	2.8
Stocks at end of June	25,029,000	**27,433,000**	9.6
Total production for year to date	**77,061,000**	75,048,000	—2.7
Total shipments for year to date	**73,953,000**	70,238,000	—5.3
No. of plants reporting	158	**163**	



Production, Shipments and Stocks of Finished Portland Cement, by Districts, in June, 1928 and 1929, and Stocks in May, 1929

District	Production—June 1928	Production—June 1929	Shipments—June 1928	Shipments—June 1929	Stocks at end of month 1928	Stocks at end of month 1929	Stocks at end of May, 1929
Eastern Pa., N. J., and Md.	**4,065,000**	3,697,000	4,081,000	**4,201,000**	**6,131,000**	5,852,000	6,355,000
New York and Maine	**1,208,000**	1,197,000	1,264,000	**1,383,000**	1,843,000	**2,009,000**	2,195,000
Ohio, Western Pa., and W. Va.	1,720,000	**1,885,000**	1,759,000	**2,046,000**	3,434,000	**3,550,000**	3,711,000
Michigan	1,456,000	**1,466,000**	**1,731,000**	1,720,000	1,955,000	**2,470,000**	2,724,000
Wisconsin, Illinois, Indiana, and Ky.	**2,446,000**	2,305,000	2,443,000	**2,707,000**	3,004,000	**3,650,000**	4,052,000
Va., Tenn., Ala., Ga., Fla., and La.	**1,391,000**	1,251,000	**1,409,000**	1,278,000	1,872,000	**2,063,000**	2,090,000
Eastern Mo., Iowa, Minn., and S. Dak.	**1,715,000**	1,607,000	2,109,000	**2,123,000**	3,131,000	**3,745,000**	4,261,000
Western Mo., Nebr., Kans., and Okla.	1,055,000	**1,089,000**	1,058,000	**1,126,000**	**1,570,000**	1,490,000	1,527,000
Texas	540,000	**554,000**	573,000	**579,000**	356,000	**510,000**	535,000
Colo., Mont., Utah, Wyo.,† and Idaho†	275,000	**325,000**	299,000	**336,000**	486,000	**509,000**	521,000
California	**1,206,000**	1,110,000	**1,255,000**	1,113,000	820,000	**995,000**	997,000
Oregon and Washington	**420,000**	289,000	**440,000**	327,000	427,000	**590,000**	629,000
	17,497,000	16,775,000	18,421,000	**18,939,000**	25,029,000	**27,433,000**	29,597,000

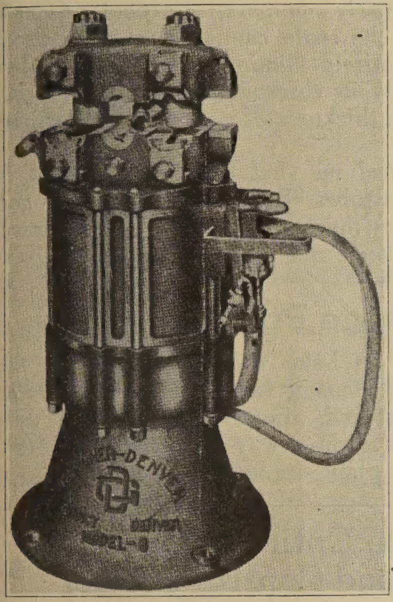
Production, Shipments and Stocks of Finished Portland Cement, by Months, in 1928 and 1929

Month	1928—Production	Production—1929	1928—Shipments	Shipments—1929	Stocks at end of month 1928	Stocks at end of month 1929
January	9,768,000	**9,881,000**	**6,541,000**	5,707,000	25,116,000	**26,797,000**
February	**8,797,000**	8,522,000	**6,563,000**	5,448,000	27,349,000	**29,870,000**
March	**10,223,000**	9,969,000	**10,135,000**	10,113,000	27,445,000	**29,724,000**
April	13,468,000	**13,750,000**	13,307,000	**13,325,000**	27,627,000	**30,151,000**
May	**17,308,000**	16,151,000	**18,986,000**	16,706,000	25,984,000	**29,597,000**
June	17,497,000	**16,775,000**	18,421,000	**18,939,000**	25,029,000	**27,433,000**
July	17,474,000		19,901,000		22,580,000	
August	18,759,000		21,970,000		19,374,000	
September	17,884,000		20,460,000		16,799,000	
October	17,533,000		19,836,000		14,579,000	
November	15,068,000		11,951,000		17,769,000	
December	12,189,000		7,384,000		22,650,000	
	175,968,000		175,455,000			

Mill Equipment

New Small Drill Steel Sharpener

A new model DS-3A double-cylinder small drill steel sharpener has just been placed on the market by the Gardner-Denver Co., Denver, Colo. Low air consumption and unusual power are the outstanding features of this machine, according to the manufacturer. It is 44½ in. high and has a base diameter of 24 in. Weight is 1500 lbs.



This new drill sharpener is equipped with two vertical cylinders. The upper piston is utilized independently in forging operations and the lower piston is brought into play only when clamping. Both cylinders, however, are used in clamping, thus giving it added clamping power.

This machine will forge bits and shanks and sharpen section drill steel not exceeding 1¼ in. in diameter and not requiring bit of more than 2½ in. in diameter, it is stated.

It forms lug shanks on 1, 1⅛ and 1¼ round steel and makes collared shanks of 3¼ and 4¼ in. on ⅞- and 1-in. hexagon or quarter-octagon steel.

Small Starter for Throwing Motors Across the Line

A new manual starting switch announced by the General Electric Company is designed particularly to meet the demand for a small device which will throw motors across the line. The switch bears the designation CR-1038-E-1 and has a maximum rating of one horsepower 110 volts and two horsepower, 220 to 600 volts, 3 phase.

The device consists of a tumbler switch and two small thermal cutouts mounted on a common textolite base. By means of suitable interlocks, the switch can be locked in either the open or closed position.

The links are made of tinned copper to prevent oxidation, and the contact spring and post are also tin plated for the same reason.

Improved Pressure Governor

The General Electric Company announces an improved design of its CR-2922 pressure governor, designated as Form B-1. The changes result in improved appearance, greater strength of some vital parts, simplification and generally better electrical design, it is stated.

To increase the reliability of the governor, the impulse-type relay has been replaced by a potential relay. On low pressure, the relay is energized and remains energized through a holding interlock, until the relay coil is shorted out on high pressure through a series resistance. The contact and gauge mechanism has been made very rugged and special provision has been made to prevent the gauge mechanism from getting out of alignment with the contact mechanism. The Bourdon tubes on gauges 300 pounds rating and below are mounted two in parallel, one actuating the needle and the other, the contact mechanism. This insures accuracy in operation and indication.

Another improvement is by allowing the incorporation of gauges in sizes up to 10,000 pounds. The limit in the former design was 800 pounds.

New Cincinnati 1200 Series Gasoline Locomotives

The Locomotive Division of The Cincinnati Car Corporation, Cincinnati, Ohio, is announcing its new 1200 Series gasoline powered, gear driven, industrial locomotives that embody numerous improvements in design and construction.

The basic idea in all the different models of this 1200 Series is performance, or the amount of work done in a given time, rather than a locomotive weighing so many tons, as the manufacturers call attention to the fact that weight is a secondary consideration in the average track haulage job.

Four good starting and traveling speeds, both forward and backward, are provided so that with the liberal amount of engine power provided, through variation in throttle, or engine speed, very marked flexibility in speed and performance is possible.

A large ratio of engine horsepower per ton of locomotive is provided in the heavy, rugged, slow-speed engine used in the different models, so that a very liberal drawbar-pull is available in all the different speeds, and at speeds that permit of loads being hauled at a good rate.

To insure long life and proper functioning of the engines, they are provided with oil purifier, gasoline strainer, and temperature gauge, the latter being mounted on an instrument panel in the cab with gasoline gauge, oil gauge, ammeter, and the different switches for control of ignition, lights and starting equipment. A spray-pump primer is also provided to assist in starting in cold weather.

INDUSTRIAL LITERATURE

Boiler Baffling

An article on "Baffling for Straight Tube Boilers" occupies an entire recent issue of "The Safety Valve," published by the *Combustion Engineering Corp.*

The article, by Walter Siegerist, assistant general sales manager of Combustion Engineering Corporation, illustrates and describes various types of baffles, their relation to straight tube boilers, the materials used with comparative tests of several baffling materials, and various types of baffle arrangements to meet certain combustion requirements.

Linestarter Publication

"Power at the Touch of a Button," special publication No. 1842, released by the *Westinghouse Electric and Manufacturing Company*, describes linestarters and linestart motors and their application to modern industries. The booklet explains the linestarter principle which permits motor control at the push of a button, and the linestart motor which may be started across the line without the use of the linestarter if high starting current is not objectionable. The features and applications of the equipment are described. Numerous illustrations supplement the description throughout the booklet.

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Simple Method of Removing Scale Disclosed

By W. F. SCHAPHORST

A prominent manufacturer of evaporators taught me a useful kink a number of years ago for removing scale. The method is used in his evaporators and he informed me that it works very well. The kink might come in handy for others.

The evaporator is a reversible process design. Possibly some readers are familiar with it. It is so made that in a six effect apparatus, for example, either end mav be the first effect and either end effect may be the sixth effect. Thus, steam is first admitted into one end at a given pressure and temperature and it comes out of the other end at a lower pressure and temperature. After several days of operation, depending upon the amount of scaling matter contained in the liquor or water, the process is reversed. Steam is admitted into the "other" and the tubes which were formerly comparatively cool are now warmer. As a result the scale cannot form to a great depth. Scale is not entirely eliminated in this way but when operated properly its thickness seldom if ever becomes greater than the thickness of an ordinary business or "calling card."

Similarly he informed me that this same method is applicable to condenser tubes. By alternately heating and cooling condenser tubes they will expand, and contract, causing the scale to loosen and fall off.

Newaygo Progress

The foundation site on Lake Michigan beach for the new Newaygo Portland Cement Company at Charlevoix, Michigan, has been staked. Contracts for three new bridges on the railroad right-of-way from the Pere Marquette main line to the plant site have been let.

Calaveras Wins Entire Cement Contract for Flood Control Project

The Calaveras Cement Company, San Francisco, Calif., has been awarded the contract to supply all the cement for the Stockton flood control project, on which construction is to start about September 1st. About 100,000 barrels will be required.

The dam is located on the Calaveras river about four miles south of Valley Springs and 14 miles from the plant. Deliveries will be made for a period of about five months, February 1st being the scheduled completion date.

Installation of large additional storage facilities for both stone and clinker and construction of five more concrete silos for the storage of finished cement have more than doubled the storage capacity of the plant, near San Andreas.

Blasting in the second bench in the quarry, it is also reported, has made available broken limestone sufficient to run the mill for several months without additional blasting. The quarry is located but a quarter of a mile from the plant.

Poliet et Chausson Increases Capital

The French cement firm Establissements Poliet et Chausson, has increased its capital from 65,000,000 to 80,000,000 francs ($13,000,000 to $16,000,000) by an issue of stock to the group formerly in control of the recently absorbed Societe des Ciments de Beaumont-sur-Oise.